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### ESTABLISHING VEGETATION ON EROSION-PRONE LANDFILL SLOPES IN ONTARIO

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#### INTRODUCTION

Landfills are used in Ontario for the disposal of waste materials. Sites can accept wastes from municipal, commercial and industrial sources, depending upon their licence restrictions. Owned by either public or private operators, landfills vary in size from less than a hectare to over 50 ha. The larger sites tend to be those that are closer to major urban areas.

Landfills take one of three general forms in Ontario: a hill or mound, a filled valley, or an excavated trench, backfilled with waste. The mound may have originated in depressions or excavations such as abandoned pits or quarries. Both the mound and valley filling operations can result in steep slopes. The backfilled trench generally results in a flat, final grade.

Intermediate soil cover is required on all waste throughout the operation. The soil cover, upon site closure, is increased with a cap material; generally between 0.5 m and 2 m of clay. A cover of topsoil, where available, is overlain to enhance final landscaping conditions.

The landfill cap is critical to the maintenance of an environmentally safe site. The soil placed on the landfill and, particularly, on the side slopes, both while the site is still operating and after closure, is prone to weathering forces which result in erosion.

Erosion not only results in a loss of soil but also in potential damage to the surface cap covering the refuse. That damage can lead to several problems:

- increased infiltration of rain water will accelerate the production of leachate,
- avenues for the movement of landfill gases and leachate will emerge,

- garbage will be exposed, resulting in an attraction for nuisance animals such as gulls,
- aesthetics will be reduced, and
- there will be additional costs for the repair of the damaged cap.

## BACKGROUND

The Ontario Ministry of the Environment (MOE) is concerned with the problem of erosion on landfill sites but to-date the extent to which the problem occurs in Ontario has not been documented.

In 1987, the MOE commissioned a 3-year research study, the goal of which is to develop a practical approach to remediate erosion on landfill sites via proper vegetation management. A discussion of the study's main objectives and findings to-date is provided here.

The 3 components of the study are:

- an overview of erosion of landfill sites in Ontario,
- identification of the best revegetation techniques,
- establishment of demonstration plots throughout Ontario.

The work undertaken in each of the study's components is briefly summarized below, up to and including the second-year study progress.

## APPROACH

### Overview of Erosion on Landfill Sites in Ontario

A questionnaire was distributed to the Abatement Officers at 22 District offices of the MOE. As their responsibility lies with the enforcement of proper landfill management, they were contacted to provide a current objective view on landfill erosion throughout Ontario.

- Each participant in the survey was asked to provide:
- a description of their landfill-related responsibilities,
  - their views on landfill erosion in their specific district, and
  - examples of typical landfills which had the potential to host revegetation demonstration plots.

Responses to the questionnaire provided 52 example landfills. The study team screened this number, down to 24 (4 in each of the 6 MOE Regions) for field investigations.

Field data documenting physical and biological characteristics were collected during September, 1987 for each of the 24 landfill sites. The physical characterization included: collection of soil samples, and observations regarding soil type, depth, grain size, moisture, temperature and compaction. The samples were analyzed for macro nutrients, pH and organic matter. The biological characterization included an assessment of the vegetative condition of each site. Percent vegetation cover, species composition and vegetation health were evaluated. The presence of site disturbances including erosion were rated using a relative scale developed during the testing of field techniques.

### Identification of the Best Revegetation Techniques

The questionnaire results provided information about site history and the revegetation approach undertaken. That, in conjunction with field work, provided some indication of what techniques were or were not effective.

Literature from throughout North America was reviewed. Successes and failures were evaluated. The most appropriate techniques for site preparation, planting and maintenance were investigated.

Based on the physical and biological data collected during field investigation of the 24 landfill site, 8 sites were chosen for demonstration plots because of their suitability for the preferred vegetation management techniques identified earlier.

Seven plots were planted in May and June, 1988, the eighth being planted in September 1988. The characteristics of each plot varied with respect to the following parameters:

- site preparation (e.g., tillage, fertilization),
- seeding techniques (e.g., hydroseeding, seed drilling),
- mulching techniques, and
- seed mixes.

There were four plots established in each of the 8 sites, generally covering an area of between 0.5 and 1 ha. The number and location of plots were dictated by the configuration of slopes available for testing.

## FINDINGS

### Overview of Erosion of Landfill Sites in Ontario

The following summarizes key findings from the questionnaire sent to all MOE District offices.

- there was an 86% response rate,
- all those returned provided specific examples of landfills, on which erosion was a problem and/or there were areas suitable for test plots,
- 73% of the respondents completed the general assessment portion of the questionnaire,
- of those, 56% reported landfill erosion to be a moderate concern and 44% reported it to be a minor concern.

A variety of problems associated with landfill erosion were reported. The exposure of buried refuse and increased remediation costs were cited most frequently. A few districts reported decreased aesthetics, nuisance wildlife problems, siltation of nearby streams and an increase in complaints from the public.

The questionnaire also revealed that the physical character of landfills vary throughout the province. For example:

- landfills are generally covered with either clay or sand, but some districts suggested that the cap was/is composed of whatever material is available (eg. inert industrial waste),
- Southern Ontario landfills (south of Pre-Cambrian Shield) commonly use clay as the cap material,
- North of the Pre-Cambrian Shield, clay is much less available and cap materials are usually sand,
- 63% of the respondents reported that revegetation was either sometimes or never completed after landfill closure
- 37% reported that revegetation was attempted frequently or always. The majority of the revegetation efforts included only grading and seeding. Less than 20% of the districts reported any tillage or fertilization prior to planting. Thirteen percent reported tree planting was also practiced on closed landfill sites.

A summary of some field data collected is provided on Table 1. The 24 sites are separated by MOE region and district. The degree of erosion and vegetative cover entries are based on a relative scale.

Key findings are presented in a series of results-statements.

- 88% of the landfill sites inspected revealed the presence of erosion. The sites that did not, had been closed for several years, and/or did not have side slopes.
- 50% of the landfill sites inspected were open and 50% of the landfill sites inspected were closed.
- 100% of the active landfill sites displayed erosion and 83% of the closed sites displayed erosion.
- The nature of the problem of erosion differed when open and closed sites were compared. The greatest erosion occurred on active sites which were commonly characterized by steep, bare slopes, with scattered growth of volunteer or invading grasses and herbaceous plants. Plants typically occurring included Ragweed (*Ambrosia artemisiifolia*), Chickory (*Cichorium intybus*), Wild Carrot (*Daucus carota*) and Spotted Knapweed (*Centaurea maculosa*).

Erosion on closed slopes appeared to be prompted in some cases by: landfill gas production and resultant vegetation mortality, poor or no vegetation establishment after closure, and leachate seepage.

#### Identification of the Best Revegetation Techniques

Field results suggest that grading and seeding alone are not adequate to ensure the complete revegetation of landfill slopes.

A review of existing information suggests the best techniques can be grouped under three main headings:

- site preparation,
- planting, and
- maintenance.

#### Site Preparation

One of the main limiting factors in revegetation success is soil compaction. Surface compaction prevents emerging seedlings from penetrating and establishing. This condition is particularly severe on sites capped with silt or clay but without a topsoil cover. Shallow tillage breaks up that surface layer allowing seedling establishment. Equipment such as the rotary tiller or spike-tooth cultivator are well suited to this work. To limit damage to the integrity of the cap, tillage should be restricted to the upper 15 cm of soil.

Topsoil or other materials high in organic matter (eg. sewage sludge, wood waste, paper sludge), can provide a much improved growing medium. Fertilizer and lime may be required on a site-specific basis depending upon soil conditions.

#### Planting

Techniques for planting turf include hydroseeding, broadcasting and seed drilling. The effectiveness of each varies by site condition. Hydroseeding for example is particularly suited to very steep slopes where access by tractor is limited.

The material selected for planting is important. This study focused on the establishment of a dense, shallowly-rooted turf which would limit infiltration, thereby reducing the potential for damage to the landfill cap. Species selected for planting included: Smooth Bromegrass (*Bromus inermis*), Redtop (*Agrostis gigantea*), White Clover (*Trifolium repens*) and Timothy (*Phleum pratense*).

#### Maintenance

The vegetation systems identified in this program were aimed at providing a low maintenance landscape. Mowing in highly visible areas and periodic fertilizing were the two main needs identified.

#### SUMMARY

Erosion is a problem on both open and closed landfills in Ontario. Along with conditions of compaction and low fertility, surfaces of landfills often have special problems; the production of gases and leachate. Adequate revegetation is part of the answer to reducing the erosion problem. The technology exists to improve on revegetation success in the province. The communication and implementation of that technology is important. Current guidelines do not provide specific advice for final landscaping. Follow-up inspections by the OMOE should be continued beyond a 2 - 5 year horizon. A long term program should be instituted to ensure landfill cap integrity.

The end product of this 3 year investigation, a landfill revegetation manual, will be of assistance in communicating that technology.

#### ACKNOWLEDGMENTS

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